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UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

SOME OF THE WELFARE PROBLEMS OF THE MINING INDUSTRY AND WHAT THE BUREAU OF MINES HAS DONE ABOUT THEM

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BY

D. HARRINGTON

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SOME OF THE WELFARE PROBLEMS OF THE MINING INDUSTRY AND WHAT THE BUREAU OF MINES HAS DONE ABOUT THEM[1]

By D. Harrington[2]

INTRODUCTION

The organic act establishing the Federal Bureau of Mines and approved May 16, 1910, had as one of its provisions the following:

> That it shall be the province of said bureau and its director, under the direction of the Secretary of the Interior, to make diligent investigation of the methods of mining, especially in relation to the safety of miners, and the appliances best adapted to prevent accidents, the possible improvement of conditions under which mining operations are carried on, the treatment of ores and other mineral substances, the use of explosives and electricity, the prevention of accidents, and other inquiries and technologic investigations pertinent to said industries, and from time to time make such public reports of the work, investigations, and information obtained as the Secretary of said department may direct, with the recommendations of such bureau.

The act was amended in 1913 (approved February 25, 1913), section 2 of the amended act reading:

> That it shall be the province and duty of the Bureau of Mines, subject to the approval of the Secretary of the Interior, to conduct inquiries and scientific and technologic investigations concerning mining, and the preparation, treatment, and utilization of mineral substances with a view to improving health conditions, and increasing safety, efficiency, economic development, and conserving resources through the prevention of waste in the mining, quarrying, metallurgical, and other mineral industries; to inquire into the economic conditions affecting these industries; to investigate explosives and peat; and, on

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behalf of the Government to investigate the mineral fuels and unfinished mineral products belonging to, or for the use of, the United States, with a view to their most efficient mining, preparation, treatment and use; and to disseminate information concerning these subjects in such manner as will best carry out the purposes of this Act.

Both the original and the amended acts indicated that health and safety of the mine workers constituted the chief function of the Bureau, and that this was the construction placed on the Bureau's activities by those put in charge in 1910 is very definitely shown by the fact that immediately upon coming into existence on July 1, 1910, both health and safety activities were started in the Mine Accidents Division of the Bureau. Before the end of the first fiscal year (June 30, 1911) six mine safety stations had been established at various parts of the United States and six mine safety cars had been put into the field; by October 1910 first-aid training work was being done in mining regions, and on October 30, 1911, a National First Aid Meet was held at Pittsburgh, Pa., at which first aid and mine rescue were demonstrated. During the fiscal year 1911, the first year of the Bureau's existence, 509 persons were given certificates indicating completion of the Bureau's training course in first aid.

Within a few months after creation of the Bureau in July 1910 an arrangement was made with the United States Public Health Service by which doctors of that organization could cooperate with engineers of the Bureau of Mines in investigations to improve the health of persons engaged in the mining and allied industries. The Bureau also employed doctors through the Civil Service, but about 1914 a fairly definite arrangement was made with the Public Health Service. At first the health work of the Bureau was largely in the nature of making surveys of various kinds, and 1914 marks the date of the first study on a definite problem - that of Dr. A. J. Lanza and Edwin Higgins on silicosis in the Joplin (Mo.) region, followed in 1916 by a similar study in the Butte (Mont.) region by Dr. A. J. Lanza and D. Harrington. In 1916 to 1920 field studies on dust and ventilation, the chief conditions affecting the health of underground workers, were conducted in coal as well as metal mines in numerous mining localities in several States by a corps of engineers and doctors under the direction of D. Harrington. In 1920 the position of chief surgeon was created and Dr. R. R. Sayers of the United Public Health Service was appointed to fill it, after which the health work of the Bureau of Mines was conducted largely in the laboratory, though some field health activities were continued. The Health Division, as such, was created in 1926 as one of the divisions of the Health and Safety Branch, with Dr. R. R. Sayers in charge, and much laboratory work, largely of a pathological nature, was done largely in connection with gases and dusts. The work of the Health Division was recessed in 1933, when Bureau of Mines funds were seriously curtailed, and was resumed in a limited way in 1935 with Dr. H. H. Schrenk in charge as chief chemist.

WORK OF HEALTH AND SAFETY BRANCH

The Bureau pursues two general lines of investigation - field and laboratory studies designed to bring about safer and more healthful conditions

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among workers in the mining and allied industries, and studies of new and improved methods for mining, treatment, and utilization of the numerous mineral materials essential to present-day human welfare. The mining, quarrying, metallurgical, and petroleum industries of this country give more or less direct employment to well over 2,000,000 persons; hence, with their dependents, the welfare of probably 10,000,000 persons is fairly definitely affected by the Bureau's work of various kinds.

The Bureau has no legal authority to enter mines or other establishments or to enforce its recommendations as to health, safety, or efficiency, the regulation of mining and other mineral industries being vested in the individual 48 States rather than in the Federal Government. The Bureau therefore relies upon the cooperation of the mining industry and of the various State mining and other departments (chiefly through educational work such as the issuance of published papers and pamphlets and the giving of first aid and other safety training courses) to make its findings and recommendations effective in trying to improve conditions not only as to health and safety but also as to efficiency and conservation.

The Health and Safety Branch of the Bureau of Mines is essentially a service organization, though considerable research work of various kinds is done also, not only on the health side but in safety also. The branch now has 99 persons in its two divisions - 82 (29 safety instructors, 23 engineers, 13 clerks, and 7 others) in the Safety Division and 17 in the Health Division, the latter engaged largely in laboratory work on health and safety effects of gases and dusts. Members of the Safety Division personnel are stationed in 17 States and do field work in nearly every State in the Union. The 17 persons in the Health Division are stationed in Pittsburgh, Pa., and Washington, D. C., and every year considerable field work is done in several States in coal and metal mining and also in petroleum. The annual appropriations for the Health and Safety Branch aggregate less than those for the State coal-mine inspection force of Pennsylvania; its duties in connection with promoting the health and safety of the approximately 2,000,000 persons in the mining and allied industries (covering coal, metal, and nonmetallic mineral mining, quarrying, and the metallurgical, cement, and petroleum industries) involve activities in virtually every State in the Union and Alaska.

Lacking police or regulatory authority, the main function of the branch is educational, and in this activity utmost effort is expended to secure and maintain close cooperation with workers, employers, State inspection and enforcement organizations, and numerous other agencies engaged in promoting health and safety.

In the various educational activities of the Safety Division its engineers and safety instructors annually come into fairly close personal contact with approximately 300,000 persons in the mineral industries; it is estimated that in the fiscal year 1938 the approximately 60 engineers and safety instructors had fairly close contact with at least 500,000 persons in the mining and allied industries. The first-aid training work constitutes the most intimate and in some ways the most effective method of putting before

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the mining industry (both employer and employee) up-to-date health and safety data; in other words, the first-aid training course as now given is excellent accident prevention "propaganda", and probably its most valuable feature is that it reaches workers in large numbers, as over 100,000 now take the course annually. More than 1,000,000 mining people have taken this course, and it is estimated that through it at least 200 lives are saved annually and probably at least 10,000 nonfatal accidents in the mining and allied industries are prevented because of the "safety consciousness" given to those who take the course of instruction as taught by present-day Bureau of Mines methods and instructors. During the past fiscal year the first-aid training was given in 790 mining communities in 38 States, 102,698 persons receiving certificates for having completed the course.

Those who have been engaged for any considerable period in the field activities of the Bureau of Mines in health and safety have long been of the opinion that nearly all matters pertaining to health, safety, and efficiency in the mineral industries are so interlocked inherently that any attempt to try to engage in any one without paying due attention to the other is almost certain to result in ineffectiveness if not in absolute disaster. Hence, the Bureau of Mines employees in the Health and Safety Branch are prone to associate all three of these phases of mining whenever anyone is brought up for discussion or action; and most of the hundreds of pamphlets issued by the health and safety workers of the Bureau of Mines since its inception in 1910 have recognized this interdependence in some manner. (A limited bibliography of published data issued on health and safety by Bureau of Mines personnel is appended to this paper.)

MINERS' WORKING CONDITIONS

No major industry has any greater need to safeguard the health and safety of workers than has mining, and it is generally admitted that mining is an ultra-hazardous occupation unless the utmost precautions are in effect at all times. On the health side, mine workers are subject to essentially all of the ills and ailments that affect persons who spend their time on the surface; in addition, they are confronted with definitely unusual health problems almost wholly related to their atmospheric environment.

Health is the greatest asset of miners, as it is of all human beings. To miners, however, it is probably relatively more valuable than to most people, as their occupation almost invariably demands more than ordinary physical ability, particularly endurance. In other words, miners must be "he-men." When their health fails, they are usually relegated to the scrap heap. For this reason many ex-miners, at a relatively early age in some cases, become watchmen, truck farmers, chicken raisers, or owners of drink emporiums or pool halls or are engaged in some similar occupation.

Miners have some advantages, as well as numerous very definite disadvantages, as regards health in comparison with persons engaged in other types of industrial endeavor. Practically all miners are forced to take considerable amounts of exercise, and our medical authorities tell us that only through exercise can good circulation of the blood and the efficiency of all vital organs be maintained.

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Any person who loads 6 to 10 or possibly 20 tons of coal or rock per day, or who "wrestles" all day with a several-hundred-pound drill or a several-thousand-pound mining machine, or who follows a mule in hauling scores of cars of coal or rock, or who walks or partly runs through several miles of muddy, low, or hot underground workings, or climbs several hundred or possibly several thousand feet of ladders per day, certainly expends plenty of physical effort. In this he undoubtedly derives numerous advantages (as well as some disadvantages) over those whose work is sedentary.

Underground Temperatures

In general, mine workers in reasonably well-conducted mines, especially in bituminous-coal mines, have almost ideal conditions in their working places as to temperature and humidity; hence, they are nearly immune to the vagaries or vicissitudes of the weather. The underground air temperature at the working places is usually around 60° F. (generally between 50° and 70° F.), with the relative humidity around 80 or 90 percent, both temperature and humidity conditions being ideal for health and for efficiency in the performance of work. In most mines the temperature of the working places varies little, if at all, throughout the hour, day, week, or year; if there is any variation, it is relatively so slight that underground workers are usually free of danger or inconvenience from heat or cold and rain or snow or wind conditions on the surface.

There are exceptions, however. Many deep mines have high temperatures, others have both high temperature and high humidity, and the workings of shallow mines are very likely to be affected by outside climatic conditions, including also, to some extent, winds. Notwithstanding these exceptions, underground workers usually have favorable "climatic" conditions at their place of employment.

Ventilation in Coal Mines

Coal mines usually have "good" air and generally far better ventilation systems than other types of underground operations, due largely to the fact that explosive gas is feared even when not actually present, and State regulations, as well as the desire for self-preservation, point out the advisability of ventilating. As a result, most coal mines have definite and fairly effective ventilating systems, and the chemical quality of the air is usually excellent. Ordinarily, the oxygen content of the air of coal-mine working places is over 20 percent, and carbon dioxide is less than 1 percent.

Every year, however, the Bureau of Mines field men find scores of instances in which air in working places of supposedly well-ventilated coal mines has oxygen below 20 percent (in some instances below 18 percent) and carbon dioxide above 1 percent or even as high as 2 or 3 percent. During the past few years far too many samples of air taken at working places of coal mines have contained carbon monoxide gas in definite quantities (0.01 to 0.03 percent), this gas being found in poorly ventilated places in which black blasting powder or its supposedly "safer" alternative, pellet powder, is used. More than 1 percent of methane is rarely found in coal-mine working

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places, though there are occasional instances, especially in anthracite mines with pitching beds, of asphyxiation of workers upon entering atmospheres containing so much methane as to reduce the oxygen content below respiratory requirements, the resultant unconsciousness or often death being due to lack of oxygen rather than to the high methane content.

The air in metal or nonmetallic mineral mine working places is far more likely to be chemically deficient or contaminated than is that in coal mines. This is due to the fact that noncoal mines are supposed to be free of explosive gas (though explosive gas actually is found in some noncoal mine workings); hence, neither the State laws nor considerations of protective expediency force them to install, maintain, and operate really efficient ventilation systems. As a consequence, in many noncoal mine workings where there is little or no effective air circulation one is likely at almost any time to find air with oxygen below 18 percent, or 1 or more percent of carbon dioxide or various kinds of noxious fumes, such as carbon monoxide, oxides of nitrogen, or various sulfur gases from blasting with dynamite and fuse. In addition, some noncoal mines use steam or gasoline engines of various types underground, so the workings are almost certain to be more or less contaminated with poisonous gases at times.

Wet Mines

The air of mine working places, while sometimes containing abnormal gas constituents, is not generally so defective chemically as to menace the health of workers; yet, in many instances there is enough carbon monoxide to cause headaches or other more serious symptoms, and occasionally enough to cause death. In some instances, mine air becomes so deficient of oxygen as to cause workers to exert undue effort in their work; in others to cause them serious physical symptoms and even to bring about unconsciousness or death. Distinctly poisonous gases, such as hydrogen sulfide, sulfur dioxide, oxides of nitrogen, and numerous others, are found occasionally, sometimes causing relatively light symptoms, such as more or less serious irritation of the eyes, throat, or lungs; occasionally they have serious permanent physical or physiological effects and may even cause death.

Some mines are definitely wet, and many have some workings that are wet, but by far the greatest number of underground workers have dry surroundings in which to labor. While the wet workings usually have some advantages and some equally definite disadvantages as regards the effect on the health of miners, it is equally true that the dry working places have both good and bad features; unquestionably, the much more pleasant working conditions in dry places carry with them far more health and safety hazards to underground workers than do the wet places.

Wet places in a mine may merely have water or mud on the floor, or water may fall through the air like rain, ranging from a drizzle to a downpour. The ill effects vary. In certain lead ores the water may carry lead compounds in solution and lead poisoning may affect the workers. Under some conditions in copper mines, copper salts are dissolved in the water and the workers have what are termed "copper sores", and unless their feet are well-protected from the water they may become too sore for walking.

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Where the water and air are cold (and some metal mines have a temperature around 40° F.), workers are likely to be subject to respiratory trouble such as bronchitis or pneumonia, or they may have what is termed rheumatism. In wet mines having high temperature (and many have air and water temperatures up to 100° F. and some around or over 150° F.), the workers are likely to be afflicted from time to time with boils or to become weakened from too profuse perspiration, or from undue heart strain, and in wet mines in climates with really cold winters, unless extraordinary precautionary measures are taken, the workers are likely to suffer undue exposure in wet clothing upon coming to the surface.

Although those who work in wet places in mines thus have some health hazards and although their work usually is done under decidedly unpleasant conditions, they are likely to escape the real scourge of the miner and one to which nearly every underground worker in dry mines or even in dry places in wet mines is subject, namely, the dust hazard. In wet coal mines workers have relatively little fear of the widespread coal-dust explosion, which may wipe out the lives of all in the mine; nor do they need to fear that their lungs or bronchial tubes or throat may become incapacitated through breathing very finely divided dust particles floating in the air. Workers in wet mines, whether producing coal or other material, have the satisfaction of knowing that miners' consumption is not likely to afflict them and carry them to an untimely death.

Dust-Producing Operations

In mines that are dry, or in dry places in mines that might be termed wet as a general condition, nearly all of the ordinary mining processes tend to produce or to disseminate dust. Certainly, blasting, shoveling, hauling, timbering, dry drilling, chute loading, and other activities in dry metal or nonmetallic mineral mines are very likely to be dust producers; and, with equal certainty, blasting, drilling, shoveling, cutting, machine loading, hauling, and other essential coal-mining activities tend to "make" dust. In both coal mines and dry noncoal mines much of the dust is very fine and is in suspension in the air breathed by the workers.

For generations it has been known that under some conditions breathing certain kinds of dusts has a harmful effect on the health, and much has been written about dust diseases such as silicosis from the breathing of siliceous dust, anthracosis from the breathing of coal dust, siderosis from dust from iron ores, asbestosis, etc. The term that indicates dust disease in general is "pneumonoconosis", and, as a matter of fact, this is very probably the term that should be given to any dust disease that affects the lungs or lung passages. There is good reason to believe that no one particular dust is entirely responsible in any individual for any of the dust diseases, such as silicosis, anthracosis, siderosis, or others of like nature.

DUST - AN ENGINEERING PROBLEM

After more than 20 years of study of the engineering phases of dust disease in mining, the study including the taking of air-dust and other samples and readings of various kinds in several thousand mine working places

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in about 20 States and in coal as well as metal and nonmetallic mineral mines, it is the writer's opinion that breathing large quantities of relatively finely divided dust over long periods ultimately will be very likely to harm the health. This includes not only siliceous dust (whether as free silica or in combined form as silicates or otherwise), but also bituminous-coal or anthracite dust or dust of iron ore, limestone, alumina, or any other mine dust, or any or all combinations of those dusts.

Moreover, the dust problem, at least in and around mines both as regards health and safety in coal mining and as regards health in noncoal mines, is or should be almost entirely an engineering and operating problem. It now is used largely as a type of racket in which the victims of dust disease get little or no relief, financial or otherwise, yet the mine operators, chiefly through their own sins of omission, are harassed by lawsuits or foolish regulations. Moreover, well-meaning but poorly informed law-making bodies or investigating committees promulgate regulations or laws on dust disease, chiefly with reference to silicosis, an ailment all but impossible to diagnose accurately, when, as a matter of fact, no definite data are available as to numerous essential factors, among them the kind of dust that will induce "silicosis", or the size, or number, or weight of the particles, or the percentage of silica in any dust to make it harmful, as well as numerous other data essential to a really correct determination of the definite cause of the injury to the health of the victim, even though the injury itself may be readily apparent.

With our decidedly limited knowledge of the actual underlying facts concerning the causation of dust disease, the only safe method of handling the problem at present is to accept the ideas that the long-continued breathing of air containing large quantities of very finely divided dust will almost certainly have harmful physical effect sooner or later and that the only known "cure" is the prevention or limitation of the occurrence of dust in mines. This is an engineering-operating problem and one entirely within the control of those who operate mines.

Unquestionably, dust disease is the greatest health menace to miners, whether engaged in coal extraction or in mineral mining, and many of our miners are obliged to breathe far too much fine dust.

The outstanding remedy for this bad situation in mines (in many localities a most distressing one) is education - education of mine workers in the necessity of taking such precautions as are available; of mine officials to recognize the seriousness of the situation and to provide equipment and methods to reduce or prevent the incidence of disease and, if necessary, to force their adoption on the miners; of doctors to correctly diagnose dust disease, give publicity to its prevalence, its seriousness, and preventive remedies and in death certificates to religiously assign miners' consumption or other dust disease as the cause where such is the case; and of the merchants, newspapers, and other influences in the community in trying to prevent the disease rather than hide its existence.

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ROCK DUSTING

The introduction of rock dust into coal mines to prevent or to limit explosions is a long step toward coal-mine safety and, if done with judgment, need not introduce any additional health hazard into coal mines. If the face regions and floor of main haulage roads of our dry coal mines are kept well-watered and rock dust is applied to all other accessible surfaces, there will be little or no health or explosion hazard. Water should be piped to all dry faces in coal mines and used on the cutting chain while undercutting, overcutting, centercutting, or shearing is done, and the face worker should sprinkle the face region within 40 or 50 feet of the face (ribs, roof, floor, and coal pile) at least three times daily as well as sprinkle (not soak) the tops of all loaded cars before they leave the face. In addition, the floor of main haulage roads should be kept well wet down.

SANITATION AND HOUSING

Sanitation in and around mines has been improved considerably in recent years, but in the majority of both coal and metal mines and mining communities much remains to be done before the miners or their families can truthfully be said to work or live under up-to-date sanitary conditions. Sewage conditions, while fair in some metal mines and good in some so-called model mining communities, in general may be termed deplorable without exaggeration. In coal mines any attempt to remedy conditions as to sewage would be ridiculed by the workers as childish or effeminate, although metal miners in many places are inclined to react with some favor to rules, regulations, equipment, or devices looking to improvement of underground sewage conditions.

Housing as well as sewage conditions in many mining communities give ample warrant for continuing to use the designation "mining camp", even though the inhabitants may resent the term "camp." The mines of the United States, with some exceptions, have not had enough assurance of stability of operation or length of life to justify the necessary expenditure for really good sanitary conditions in mining communities; this includes such features as sewers, city water systems, concrete roads and sidewalks, lawns, brick or concrete houses equipped with baths, running water, and other conveniences once considered luxuries but now regarded as necessities. Many fairly progressive mines have failed to provide a good usable type of wash house, though some mining companies have wash houses or "drys" that resemble palaces. Very likely, it would not only pay well in the various kinds of satisfaction they bring to those who work in mines, but it would also pay well in dollars and cents if the companies would do far more than they have done to provide workers and their families better welfare and sanitation facilities, including houses, amusement halls, washing, bathing, and latrine accommodations at mines, and sewage facilities in mining camps, city water systems, and other like features.

SPECIFIC REMEDIES

As specific remedial measures for metal mines the writer suggests the following: Mechanical ventilation, with some definite person or persons in charge, should be adopted to force moving currents of air to every place

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where men work to remove dust, heat, and gases. The use of water should be enforced in all drilling, in the sprinkling of ore and rock piles, in the wetting of timbers, manways, and haulageways, and in every place where dust may be found. Where possible, the blasting should all be done after a shift; where this cannot be done strict regulations should be enforced as to the wetting of the region of blasting both before and after the shots are fired, removal of all explosive fumes by adequate air currents, and prevention of entrance into a blasted place until all dust, fumes, etc., have been removed. There should also be strict physical examination of mine workers before employment and at periods of not more than 6 months during employment, with prompt removal from dangerous underground work should unfavorable physical symptoms be found.

In our coal mines education as to the dust hazard is needed badly also. The coal-mining public, instead of "standing pat" and referring to out-of-date and often misleading foreign statistics that coal dust is harmless to health or is even healthful, should make an impartial but strict study of dust conditions in coal mines (anthracite, bituminous, and lignite), paying particular attention to examination of the chest conditions, coal-camp doctors who have direct knowledge of the harmfulness of coal dust to underground workers, especially those working on mining or loading machines, should write technical articles descriptive of the situation; and State and federal authorities, as well as other interested agencies, should cooperate in making studies and publishing results as to the health situation of workers in dusty places in coal mines.

RESULTS OF BUREAU OF MINES WORK

A relatively short paper cannot adequately cover the necessities in trying to evaluate the results and accomplishments of the Federal Bureau of Mines in its health and safety efforts for the benefit of those engaged in the mineral industries, although the attached abridged bibliography of published matter issued by the Bureau in connection with investigations and their results with application to combined health and safety in the mineral industries is partly indicative of what has been done or what has been attempted.

On the safety side, some definite figures are available and are offered. During the 5-year period 1906-1910, inclusive (or just previous to the creation of the Bureau of Mines), 13,288 persons were killed in the coal mines of the United States, an average of 2,658 per year, and the fatality rate for this 5-year period was 5.89 persons killed per million tons of coal produced. The number killed in our coal mines in 1932 was 1,207, and the fatality rate per million tons of coal produced was 3.36; in 1933 1,064 were killed, a rate of 2.78; in 1934, there were 1,222 deaths, a rate of 2.93; and in 1935, there were 1,242 deaths, a rate of 2.93. Tentative figures for 1936 indicate that 1,330 fatalities occurred, a fatality rate of 2.72, the lowest coal-mining fatality rate on record; and tentative figures for 1937 show that there were 1,467 fatalities, a rate of 2.98 (tentative).

If the 5.89 fatality rate for the 5-year period 1906-1910 had continued to the first of January 1938, the number of fatalities in the coal mines of

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the United States would have been almost 23,000 greater than they actually were; hence, during the 26 years' life of the Bureau of Mines the coal-mine fatality rate has been reduced enough to indicate an average annual saving of life of more than 1,000 persons; similar figures on prevention of nonfatal accidents are not available, but it is estimated that about 50 nonfatal accidents occur to one fatality; hence, it is probable that about 50,000 nonfatal accidents have also been prevented annually. If the cost to the operator of a life is put into cold-blooded dollars and cents and a relatively low amount, such as $5,000, is taken as the "value" of a life, it will readily be seen that, irrespective of ethical or humanitarian considerations (and not considering nonfatal accidents), the annual saving of somewhat more than 1,000 lives may be considered as "worth" more than $5,000,000, or almost three times the total amount being expended by the Bureau of Mines during the present fiscal year and nearly double the entire expenditure of the Bureau for any year of its existence. If, in addition, it is conceded that as many as 50,000 nonfatal accidents per year have been prevented (and the assumption is by no means unreasonable), and the "cost" to the operator in compensation, hospitalization, etc., of a nonfatal accident is placed at $100 (some authorities estimate it at $300), it will be seen that at least an additional $5,000,000 annually has been saved to the coal industry through the safer operation of the past 26 years.

The benefits to the workers in and around coal mines due to this increased safety of operation are much more impressive than are those to the mine operator. Preventing the death of 28,000 coal-mine workers in the past 27 years has obviously avoided a vast amount of suffering, pain, and misery of various kinds to the families who would have been bereft of their loved ones. And the prevention of 50,000 or more nonfatal accidents annually for 26 years certainly has saved the miners, their families, their friends, and the community a large amount of pain, inconvenience, misery, and other losses.

The financial losses that the workers have avoided through this increased safety of coal-mine operation are in themselves colossal. The average age of the coal-mine worker who is killed is about 35 years and, in general, he should under normal conditions have a future active working period of <u>at least</u> 20 years. In normal times he should earn at least $1,000 annually, hence in his 20 years active life expectancy would receive approximately $20,000 for his services. Hence the saving of the life of about 28,000 coal-mine workers in the past 27 years through decreased death rate in coal mining has prevented a financial loss to them of at least $560,000,000, and this does not take into consideration the financial losses saved to the worker through the elimination of large numbers of nonfatal accidents. Hence, for the past 27 years an annual saving of approximately $21,000,000 has been made to coal-mine workers in the prevention of fatalities; $21,000,000 is far more than the total expenditures on safety work made by the Federal Bureau of Mines since its establishment in 1910, therefore the coal-mine worker unquestionably is reaping annual dividends of several hundred (probably several thousand) percent on the expenditures of the Federal Government in the promotion of safety in coal mining.

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The foregoing detailed facts about coal mining are more or less similar to safety conditions that obtain in the other phases of mining and allied industries, including metal mines, nonmetallic mineral mines, the petroleum industry, etc., all of which still have a relatively high rate of accident occurrence, though much progress has been made in the past 5 or 6 years.

The beneficial effects of the health work of the Bureau can by no means be as readily shown in statistical forms as can the effects of its safety work; but with respect to a considerable number of investigations, many of a fundamental nature, by Bureau of Mines personnel into gases, dusts, temperatures, humidities, and other similar matters, definite information can be given, not only as to the effect on workers but also as to protective or preventive methods, devices, and procedures. The work of the Bureau regarding respiratory protective equipment is outstanding; information given by it to the public as to the effect on health of breathing gases (carbon monoxide, hydrogen sulfide, etc.) has not been exceeded by any other agency in the United States; its early work in dust, both from the health and the safety viewpoints, constitutes the basis of information and teaching on these matters today in industrial work; and numerous other accomplishments of a fundamental character could be mentioned, the details of which cannot be given in a short paper.

The subject of health in mining, however, has not been given nearly the attention it warrants, and this is particularly true as to the occurrence of dusts, high temperatures, high humidities, and other influences harmful to the health of the mine worker. Although definite statistics are not and probably never will be available, it is almost a certainty that far more underground workers are incapacitated or die annually from breathing excessive amounts of dust than are killed by mine explosions and fires. Air-conditioning, now practically in its infancy in general industry, offers a possible fruitful means of safeguarding the comfort and health and to some extent the safety of the mine worker, and a few mining companies are making air-conditioning installations, though definite data on results are not at hand; unquestionably, much research work should be done to discover feasible methods of air conditioning mines. The Bureau of Mines has done much work on ventilation of mines as well as on methods of reducing dust, heat, humidity and similar subjects, and studies are now being conducted on dust, ventilation, etc., both in the laboratory and in the field in mines and plants in the mineral industries.

When mine disasters with heavy loss of life occur, or when single fatalities or even minor accidents occur, or when mine workers become incapacitated or die from ill health due to their occupation, much of the burden finally falls upon the coal- or mineral-consuming public or the public at large, as the high cost to mine operators of occupational accidents and ill health is ultimately passed on to the user of coal or other mineral products. In addition, while the compensation received by the victims or their dependents helps them temporarily, in general the families of crippled or killed miners, or the sickly or crippled miners themselves, become largely dependent upon the public for support for several years following an "accident" and possibly continuously as long as they live.

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Health and safety work (both research and service) in the mining and allied industries offers large remuneration in salvage of life and limb as well as in dollars and cents for dividends as well as capital investment. At present, questions in connection with occupational disease are harassing industry (both workers and employers), and mining is very deeply affected; much work should be done on the subject of dust alone, and the incentive here is one that taxes the imagination as thousands of workers are incapacitated annually by dust disease and hundreds die of it; suits involving many millions of dollars are now or recently have been in court in connection with dust disease in mines and tunnels, and this is only the beginning. Unquestionably the prevention of dust disease in mining is a problem that can be solved, and its various ramifications should be attacked constantly and vigorously; the Bureau of Mines undoubtedly is the best agency to handle the research. Numerous other health and safety problems in the mining and allied industries also can and should be solved, and again the Bureau of Mines is the logical organization to do much of the work. In safety in all kinds of mining, while much progress has been made during the past several years and tangible evidence of this progress has been apparent during the past 5 or 6 years, there is no question but that accidents in the mining industry could be reduced at least 50 percent (possibly as much as 75 percent) below what they now are, in which event the financial savings would amount to millions of dollars annually to both workers and operators, to say nothing of the admittedly great humanitarian and sociological benefits to the entire nation which certainly would accrue. Here, again, the Federal Bureau of Mines, with its vast experience in the work and with a definite record of accomplishment past and present, is the sparkplug to keep the work functioning effectively; but to enable the Bureau of Mines to do a good job, the funds allotted to it for health and safety work should be increased severalfold.

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